Issues in Bioptic Driving

by

Matt Yawney

This paper is submitted in partial fulfillment of the
requirements for the degree of

Doctor of Optometry

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Michigan College of Optometry

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ISSUES IN BIOPTIC DRIVING

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ABSTRACT

This paper reviews past and current literature and studies regarding bioptic driving, the laws and issues regarding driving with visual impairment, and optometry's role in preparing low vision patients to use bioptics for driving. While bioptics have been aiding drivers for approximately 3 decades, their use to meet vision requirements for driving remains controversial. Additionally, vision standards for driver's licensure vary greatly between states, demonstrating the differing opinions on what visual requirements are necessary for safe motor vehicle operation. Many studies have been performed to help policy makers, physicians and the public more objectively approach these issues, although in some cases they have reinforced the controversy. Optometrist's role in bioptic driving is also discussed. *Conclusions*: Bioptic training programs should be made mandatory in states that allow bioptic driving. High risk groups should be required to have a comprehensive visual examination which includes tests predictive of crash risk.

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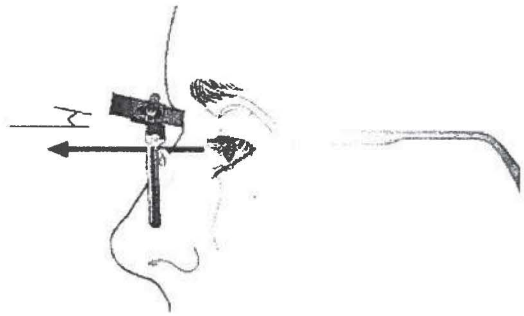
Introduction

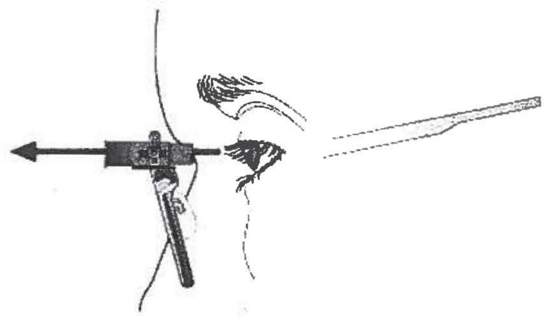
Visual impairments are prevalent among all ages but are significantly more prevalent in the elderly. Because Americans over 65 comprise the US's fastest-growing population, the issue of people with visual impairments driving automobiles is becoming increasingly important. Approximately 12% of individuals age 65 and older, representing 3.9 million people, have difficulty seeing words and letters in ordinary newspaper print even when wearing glasses or contact lenses (McNeil, 2001). While many factors other than visual acuity may contribute to motor vehicle accident fatalities, seniors are second only to teenagers in crash death rate per mile (National Highway Traffic Safety Administration, 2000). As the population ages and visual impairments increase, optometry will play a major role in determining who is, and who is not eligible to drive. Additionally, optometry's role will be to help some meet driving eligibility through prescription of a bioptic and referral for training. This article will discuss bioptic driving, the laws and issues regarding driving with visual impairment, and optometry's role in preparing low vision patients to use bioptics for driving.

Bioptic

A bioptic is a dual purpose optical device used by people with visual impairments to increase the extent of their visual capabilities. It is dual purpose in that it consists of a carrier lens (a conventional pair of glasses) combined with a permanent miniature telescope mounted superiorly in the lens or on the frame itself. The carrier lens is used for general viewing (or gross vision), while the telescope is used for identification of distant targets (or fine vision). Identification of fine targets is performed by moving the head slightly down and the eyes slightly up allowing for a brief view through the telescope (see illustration 1). Using the principle of magnification, the telescopic portion of the lens gives the wearer artificially increased acuity. Some states allow the use of a bioptic to meet acuity requirements for a driver's license.

Illustration 1: Demonstrating How a Bioptic is Used





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Bioptic Driving

Driving with a bioptic involves using the telescope for *scanning* distance conditions and *spotting* desired targets. Scanning and spotting are intended to be done at brief intervals without having to search for the target. Otherwise, a bioptic driver looks though the carrier lens approximately 90% of the time.

States that allow drivers to meet visual requirements using a bioptic require acuities of 20/40 to 20/70(depending on the state) in drivers with two seeing eyes. Monocular driver's acuity requirements range from 20/25 to 20/70 depending on the state (Brilliant, Appel, & Chapman, 1998). Of course, only acuity requirements can be remedied using a bioptic, whereas scotomas are another major limiting visual factor in licensure. Additionally, the driver's visual processing ability should be a matter of serious consideration (Park, 2002), although static visual abilities are the standard qualifier for licensure. Other important considerations include the patient's cognitive and physical status (Reed, & Brunette, 2004).

Michigan laws regarding bioptic driving

Michigan law requires drivers who are renewing their licenses to pass a vision test. At the time of renewal drivers are also asked if they have a physical, visual, or mental condition that affects their ability to drive safely. Bioptic telescopes may be used to meet visual acuity standards and will require a road test. Visual requirements for licensing in Michigan include (TransAnalytics, LLC., 2003):

1) Visual acuity of 20/40 and a peripheral field of vision of 140 degrees for an unrestricted license.
2) Visual acuity between 20/40 and 20/50 and a peripheral field between 140 and 110 degrees may be acceptable if accompanied by a statement of examination signed by an ophthalmologist or optometrist.
3) When meeting minimal visual acuity standards requires corrective lenses, a restricted driver's license is issued indicating the driver is to wear appropriate corrective lenses.
4) A driver's license may restrict the driver to daylight driving only when the licensee submits a statement from an ophthalmologist or optometrist stating one of the following:

   (a) The licensee has visual acuity less than 20/50 to and including 20/70 with no recognizable progressive abnormalities affecting vision.

   (b) The licensee has visual acuity less than 20/50 to and including 20/60 with recognizable progressive abnormalities affecting vision.
5) Other conditions and requirements of a restricted license may be issued to an applicant or

licensee who has a peripheral field of vision of less than 110 degrees to and including 90 degrees.

6) A driver's license is denied or suspended indefinitely if the licensee has any of the following:

(a) Visual acuity less than 20/60 with recognizable progressive abnormalities affecting vision.

(b) Visual acuity less than 20/70 without recognizable progressive abnormalities affecting vision; visual acuity of 20/100 or less in one eye and less than 20/50 in the other; or a peripheral field of vision less than 90 degrees.

7) Michigan allows for the preceding acuity requirements to be met with a bioptic. If eligibility for licensure is met, a road test is then required. Formal driver's training using the bioptic is only recommended and not required.

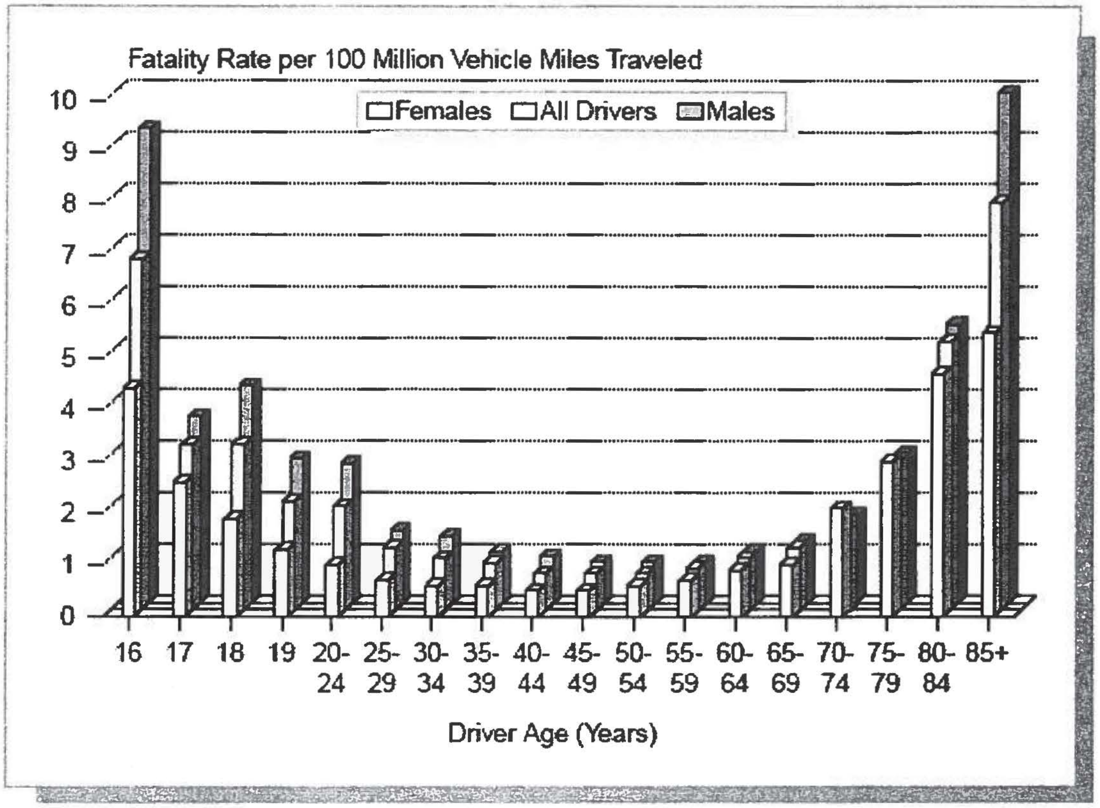
State laws outside of Michigan regarding bioptic driving

Reviewing the specifications for bioptic use in each state is beyond the scope of this paper, however a general address of discrepancies is appropriate. Fourteen states disallow the use of a bioptic all together (Wang, Kosinski, Schwartzberg, & Shanklin, 2003). Several other states allow the use of a bioptic for driving, but not to meet acuity requirements. In states that do allow bioptic use for meeting licensure eligibility, variance in standards is significant. Several states require a specified number of hours of behind the wheel training while others do not. Many indicate that the bioptic drivers have daylight only privileges. Required carrier acuity ranges from 20/50 to 20/200 (TransAnalytics, LLC., 2003). Variability in telescope acuity is from 20/40 to 20/70 (TransAnalytics, LLC., 2003). Massachusetts and Tennessee place limits on the maximum power of the telescope. Wyoming places a distance of travel restriction on the driver for the first year of licensure.

Some states have displayed a proactive approach to the issue of bioptic driving by mandating training programs. Ohio is one such state, requiring an extensive pre-licensing process before granting licenses to the visually impaired (Windsor, Ford, Fettig, & Windsor, 2002). This process involves a vision examination and bioptic fitting and evaluation by an optometrist, bioptic mobility training by an orientation and mobility specialist, through which the applicant may become eligible for a learner's license. Using this temporary learner's license, the individual can undergo training by a certified driver. Training lasts from 20-50 hours based on the driver's skill. A road test can be taken after training, which if passed will allow the driver daytime driving privileges. Under certain circumstances, a driver can obtain nighttime privileges also after completing one year of safe driving. Eleven other states have mandatory bioptic driver training programs in place.

Table 1. Driver Fatality Rates by Age and Sex, 1996

Figure 2. Driver Fatality Rates by Age and Sex, 1996



Note. From U.S. Department of Transportation. (2000). Young drivers traffic safety facts 2000. DOT HS 809 336. National Highway Traffic Safety Administration. Reprinted with permission. Available: http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSF2000/2000ydrive.pdf

Should the visually impaired drive?

Whether or not the visually impaired should drive is an issue met with several differing opinions. This is well-reflected in the inconsistent policies found between states regarding this question. Clearly, some would prefer the visually impaired not drive at all. Others, believe that with additional driver training and appropriate limitations, many people with visual impairments can drive safely. And further to the left, some would grant unrestricted license to drive with minimal visual requirements and without requirement of training.

Objective assessment of this issue requires consideration of its competing interests: freedom and safety. Automobiles for many Americans represent independence and are a significant part of seeking economic, social, and personal interests (Rosenblum, & Corn, (2002). Therefore, "stopping driving because of visual impairment is one of the hardest realities that older adults have to face, and many older adults who do so go through a grieving process, feeling shock or denial, anger at living longer, vulnerability, despair, hopelessness and social isolation as a result of psychological withdrawal, and fear" (Orr, as cited in Rosenblum, & Corn, (2002). Because of the significant psychological impact of requiring visually impaired drivers to give up driving privileges, serious consideration should be given to the merit of policies aimed to limit these privileges.

Conversely, public safety and the safety of the visually impaired driver are matters of at least equally serious concern. Age, aside from visual impairment, becomes a significant predictor in auto crash fatality past the age of 69 (see table 1). Increasingly, research traces the causes of car crashes in the elderly to "functional impairments including sensory, cognitive and physical deficits" (NHTSA, as cited by Owsley, Stavely, Wells, Sloane, & McGwin, 2001). The association between visual impairment and crash prediction has long been a topic of debate, especially on the topic of visual acuity. This is especially significant, considering that states visual standards for licensure are almost wholly based on visual acuity. Several studies evaluating the risk of auto accident in people with decreased acuity have been performed and shown varied results.

Citing a study by Ivers, Mitchell and Cumming, the Optometrists Association Australia (OAA) suggests that an increased crash rate is found in people with visual acuity worse than 20/60 in the right eye, (Ivers, Mitchell, & Cumming, as cited by Peregrine, & Chakman, 2002). Subsequently, the OAA recommends private drivers have minimally 20/40 binocular visual acuity and 120 horizontal visual fields (Peregrine, & Chakman, 2002). Recently, a study showed that even with significant driving restrictions, drivers with visual acuity between 20/80-20/100 (better eye), a 90° visual field, and stable pathology exhibited a 2.8 times increased crash rate when compared with their unimpaired, unrestricted peers (Wick, & Vernon, 2002). Drivers with low to moderate visual impairment (20/50-20/80 acuities, 120° fields and stable to unstable pathology) were associated with only mildly increased risk of auto crash (Wick, & Vernon, 2002).

Opposing views were expressed in a study by Gerald Fonda, who concluded that some people wit h stable visual acuity as low as 20/200 can safely drive when limited to daytime driving not exceeding a speed of 40 mph (Fonda, 1989). An analysis of Burg's studies of 17,500 Californian drivers found only weak, but significant correlation between static and dynamic visual acuity and driving performance in drivers over 54 years old (Hills, & Burg as cited by Sheedy, & Bailey, 1993). Visual attention as determined by the useful field of view was shown to be highly predictive of crash risk in older drivers, whereas the same study showed visual function and eye health to correlate to, and not predict crashes (Ball, Owsley, Sloane, Roenker, & Bruni, 1993). Drivers found with decreased useful field of view were shown to be six times more likely to have been involved in a crash in the five years prior to testing. A more recent study found drivers with a crash history within 5 years prior to the study were 6 times more likely to have decreased contrast sensitivity (defined as a Pelli-Robson score of 1.25 or less) in both eyes (Owsley, Stavely, Wells, Sloane, & McGwin, 2001). This study also acknowledged that visual acuity was not related to crash involvement and suggests that "safe driving may not require keen spatial resolution." Many sources suggesting that visual acuity does not best determine driver safety also recognize that it is difficult to measure the safety of drivers with severe acuity reduction. This is because such drivers are rarely on the road due to self or government-imposed driving restriction (e.g. Owsley, & McGwin, 1999; National Research Council, 2002,).

A study by Johnson and Keltner found that reduced binocular visual fields were a significant risk for crash involvement. However, this study has been criticized for poor testing methodology (**Westlake,** 2000) and for defining impairment as very significant field loss, versus similar studies with opposing findings using milder definitions (Owsley, & McGwin, 1999). Similarly controversial is the significance of dynamic acuity, binocular vision and color vision in their correlation to increased crash risk. While the usefulness of many visual function tests for determining driver safety remains debatable, the value of contrast sensitivity and useful field of vision testing is undisputed at this time.

Is bioptic driving safe?

Failing to meet acuity standards does not always equal permanent loss of driving privileges, depending on the drivers state of residence. As noted previously, some states allow the use of a bioptic to pass visual acuity requirements. Like vision impairment and driving, the safety of bioptic driving has also been a much debated topic, though less studied than visual function deficits and safe driving. Conclusions of studies relating to the safety of bioptic driving have been both positive and negative.

One of the first such studies began in 1985 when a multidisciplinary group of researchers created a study to determine the feasibility and safety of bioptic driving (Huss, 1995). Participants had a best corrected distance visual acuity from 20/50 to 20/200 in their best eye, minimal visual fields of 120 degrees horizontally, and 80 degrees vertically in the better eye. Participants also needed to achieve 20/40 or better acuity through their telescope. Initially, participants underwent evaluation, followed by a comprehensive and individualized driver training program. A standardized 40-mile test route was developed to frequently assess the driver's abilities under dynamic circumstances. Licensure with individualized restrictions was granted to 31 participants. This study concluded that drivers who completed their program exhibited visual and vehicle handling skills as well as reaction times at least equivalent to non-visually impaired counterparts.

A study in Texas showed that bioptic telescopic drivers had 1.34 times more accidents than a normally sighted control group over a 10 year period (Lippmann, Corn, & Lewis, 1988). A recent study by the California Department of Motor Vehicles found that drivers licensed to use bioptic telescopes showed fatal/injury and total crash rates 1.7 and 2.0 times higher, respectively, than those of a normally sighted comparison group (Clarke, 1997). However, the citation rate of the bioptic drivers was only 0.7 of the comparison group's rate. Also revealed was the fact that only 35% of bioptic drivers had a sunrise-to-sunset license restrictions. One result of this report was the recommendation that all bioptic drivers be restricted to day-time-only driving to increase safety.

Korb introduced bioptics to driving, giving 32 visually impaired individuals extensive bioptic training, resulting in 26 of them getting driver's licenses. He reported that these individuals logged a combined 32 man years of driving without incident (Korb, as cited by Brilliant, Appel, & Chapman, 1998).

It appears that when drivers using bioptics are compared with their normally sighted, age and gender-matched counterparts, they show an increased rate of traffic incidents. However, the claims of researchers that have conducted extensive and individualized bioptic driver training programs are that these drivers can drive as good as their normally-sighted counterparts. Intuitively, it is expected that drivers undergoing a comprehensive training program tailored to their needs would drive better than drivers who have not undergone such a program. A 2000 study found that bioptic users who received training in specified categories of visual skills showed "significantly greater improvement in 50% of the skills categories" compared to the improvement in those who received no formal training (Szlyk et al., 2000). Therefore, the disparity between the aforementioned claims and studies is understandable. Unfortunately, studies have not been performed to determine how crash rates compare between trained and non-trained bioptic drivers. It is likely that there are several people driving with bioptics that have not received any formal training with the device. Another important consideration is that training programs also act as a weeding process. Students who may meet acuity requirements, but are still poor driving candidates are eliminated from the license seeking process. States that don't have extensive training and assessment programs may be allowing these poor candidates to drive. Perhaps studies in the future will allow us to see the impact of bioptic drivers training programs on crash rates.

Optical effects of a bioptic telescope

Opponents of bioptic driving have argued that the optical effects induced by the telescope are dangerous to drivers. The two main optical effects experienced while using the bioptic are reduction in visual field and magnification. Fonda argued that the visually impaired should be granted a waiver for impaired vision rather than requiring them to purchase an expensive bioptic telescope that dangerously decreases peripheral vision if used (Fonda, 1983). Indeed, all telescopic devices result in reduced visual field, this being an inherent result of magnification. For the brief time that the bioptic user scans and spots through the telescope his visual field will be reduced. This has been compared to the quick glances that all safe drivers take to use rearview and side mirrors. The telescope is only intended to be used for 5-10% of the driving experience. Therefore, field loss should not be a significant concern.

The effects of optical magnification induced by bioptic telescopes have been referred to as the "Jack-in-the-box effect." This is due to the suddenly increased size of targets viewed through the telescope, as well as their perceptually increased speed. No doubt, this effect would be confusing to any driver initially. With training and familiarity though, the bioptic driver can become accustomed to this effect and successfully use the bioptic for driving.

Optometry's role in bioptic driving

Optometrists are not trained to be driving instructors, but they do have an important role to play in bioptic driving. As primary vision care providers, they have the responsibility to recognize potential candidates for bioptic driving. It is then the patient's choice whether or not they would like to pursue such a program. Good candidate selection is important, considering the high cost of a bioptic telescope and driver training programs. Poor candidate selection can result in a significant loss of time and money. Park recommends allowing the patient a minimum 1 week at-home trial with a loaner bioptic to confirm a patient's candidacy (Park, 2002). During this loan period the patient should undergo a static and dynamic assessment by a driver rehabilitation specialist. Low vision specialists and some primary care optometrists should understand how to fit a bioptic and introduce basic skills like scanning and spotting.

Following dispensing, a local driver rehabilitation program should be recommended. Having a general knowledge of driver rehabilitation programs will help OD's to make better candidate selections, and help new bioptic wearers to begin learning basic bioptic use skills.

Determining a patient's candidacy for bioptic driving.

Determining a patient's candidacy for bioptic driving usually begins with an unofficial physical assessment as the patient and doctor meet. Observation of the patient's strength (or frailty), reaction time, physical stability and balance help the doctor to make an initial decision as to whether or not a bioptic should be recommended (Reed, & Brunette, 2004). Similarly, an informal mental assessment is made, including patient alertness, and orientation to time and place. Ocular health conditions that will result in progressive vision impairment may also contraindicate patient candidacy. Since a bioptic can only aid a patient in passing acuity requirements, it is imperative to determine that the visual field is adequate for state requirements before spending extensive time and resources on bioptic perusal. If the field is in question, an Esterman 120° visual field can be performed. Before a bioptic for driving is prescribed, various trial bioptics should be introduced to the patient and acuity measurements taken to ensure that acuity requirements can be met within state standards. Lastly, the patient should know that meeting acuity requirements alone with a bioptic does not guarantee licensure. Some states will require behind the wheel training using a bioptic, and many will require a road test while wearing the bioptic.

Fitting

The telescope is fitted as high above the major reference point in the frame as possible, but should allow 3mm between the edge of the scope and the frame (Greer, 2002). Monocular telescopes are advised because the field reduction experienced while looking through bilateral telescopes is a safety hazard. The scope should be fitted over the eye with the best acuity. The angle of the telescope should be in-line with the eye's center of rotation when the patient is looking through the scope. This is typically a 10° angle up from perpendicular to the carrier lens (Vogel, 1991). Exact measurement for the angle of the scope can be made by holding a protractor against the carrier lens while having the patient look through the scope. The 90° angle on the protractor would be the reference angle.

A general drivers training program for bioptic wearers

Basic skills required for bioptic driving are scanning and spotting. Scanning performed by briefly sweeping over objects in the distance (about 100 yards or further) to reveal any potential hazards (Brilliant, Appel, & Chapman, 1998). Spotting can be used to identify a potential hazard as well as read signs. Spotting is performed in a single, rapid motion by tilting the head slightly down while looking up through the scope at the object in question. Scanning and spotting can be discussed and practiced briefly in the office at the time of dispensing the loaner bioptic.

Vogel suggests an initial spotting training exercise in which the patient learns to "spot stationary objects while the patient is stationary" (Vogel, 1991). Numbers are projected on a wall in staggered rows and the patient is required to spot them in sequence. First the patient sees the number through the carrier, and then she quickly spots it through the telescope. The goal is to increase spotting speed until 42 numbers can be spotted within 75 seconds. The numbers are projected in 20/40 acuity. Similar spotting exercises could easily be devised.

Park, Unatin and Herbert suggest a learning sequence in which the patient first locates stationary objects while stationary, then locates moving objects while stationary, and lastly locates moving objects while also moving (Park, Unatin, & Herbert, 1993). With some creativity, exercises could be developed for patients to practice these skills at home. The final step is performed while the patient sits as a passenger in the car and practices scanning and spotting.

In addition to these skills, Vogel's program involves practicing these skills under varying light and weather conditions, and using the scope through the rearview mirrors (Vogel, 1991). After the patient is proficient at these skills as a passenger, he is ready to begin training behind-the-wheel.

Ideally, bioptic driver candidates should be exposed to the same variety of situations in their behind-the-wheel training as will be experience in the real world. Driving courses should include unfamiliar roads, different types of roads, varying speed limits, high traffic areas (Park, 2002). Assessment should include the driver's abilities to recognize signs and road markings. Drivers are taught to drive defensively and to brake early. Common problems observed in patients undergoing such training include: using inappropriate speeds, decreased traffic awareness, poor night driving abilities, weather challenges, poor reaction time, missed signs, and poor lane changes (Reed, & Brunette, 2004).

Conclusion: Should Michigan change?

Michigan currently allows people with vision impairments to meet acuity requirements with a bioptic. However, driver training with the bioptic is only recommended, and not mandatory as in some states. A 1995 survey of Michigan bioptic drivers found that 73% of respondents underwent 1 hr or less of training (Park, W. L., Unatin, & Park, J. M., 1995). Considering the complexity of skills required to use a bioptic while driving, it is important that bioptic drivers experience a training program. Michigan should adopt a mandatory training program similar to the neighboring state of Ohio. Driver training in Ohio is estimated to last 20-50 hours, allowing for trainers to adapt the program to the driver's skill level. Additionally, licenses should have restrictions customized to the driver's disability. A recent survey of bioptic drivers found that drivers exhibited low levels of self-limitation in conditions (i.e. night driving, high traffic, rain) where the bioptic would be of little help (Bowers, Apfelbaum, & Peli, 2005). Michigan should continue to require bioptic drivers to pass a road test using the bioptic.

Outside of Michigan, there is a significant need for a national restructuring of current policies regarding vision impairment and driving. It is important that licensing policies are updated to better coincide with current research. There is a need for greater uniformity in policies and standards relating to licensure of visually impaired individuals. After reviewing current standards and practices, the American Optometric Association has recommended a mandatory comprehensive eye examination for high risk groups (Shipp et al., 2000). High risk groups were identified as first time license seekers, people involved in traffic accidents or moving violations, and individuals greater than 60 years old. Since current visual function testing methods have proven to be only weakly predictive of crash risk, useful field of view and contrast sensitivity testing should become part of regular pre-licensing examination and standards.

Requiring mandatory comprehensive examinations for high risk groups will better identify individuals who pose a significant public safety risk. Identifying disease processes and vision deficits will allow optometrists to recommend patients on treating vision deficiencies (e.g. cataract removal), self-imposing driving limitations, and getting optical correction. Updating policies to include mandatory comprehensive exams for high risk groups will make America's roads safer.

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From : Bolton, Eric <Eric.Bolton@nhtsa.dot.gov>

Sent : March 4, 2005 9:23:42 PM

To : <myawney@hotmail.com>

Subject : Permission to use a NHTSA chart

Per our discussion of Friday, March 4, you are permitted to use the table showing driver fatality rates by age and sex for your school paper. We request that you indicate that the source of the information in the National Highway Traffic Safety Administration. Thanks for your interest in highway safety.

DEAR MATT, OK TO USE THESE TWO
BUT PLEASE SEND COPY OF YOUR PAPER. B. Phillips
Trustee, BDN
3.11.05.

To 1 801 460 7341
Return Fax: 616 391 8293

Dear Webmaster (BDN),

I am a 4th year optometry student doing a research paper on bioptic driving. ~~You~~ I was wondering if I could please have permission to use the above image from your website (Bioptic Driving Network). ✓ I also would like to use the images of the patient looking through the carrier lens. ✓ Of course, I would put in a reference to your website. Please forward this to the appropriate authority if you cannot grant me to use this.

Thank-you.

Matt Yawney

FA

MATT YAWNEY

TOTAL P.01